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# A model in which monetary policy is about money

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ABSTRACT

Optimal monetary policy is studied in a model with (i) heterogeneity in the degree to which different people are monitored (have publicly known histories); (ii) idiosyncratic shocks that give rise to heterogeneity in earning and spending realizations; and (iii) central-bank intervention in a "market" in claims or credit in which the participants are those who are heavily monitored. A special case of the model has everyone perfectly monitored. In that case, there is no role for money and no role for central-bank intervention. In the example displayed with imperfect monitoring, optimal intervention is not simple.



## 1. Introduction

Most modern monetary systems evolved from systems in which there were private banknotes. In modern systems, central banks have a *de jure* or *de facto* monopoly on note issue. Optimal central-bank policy is described under the monopoly against the background of a model that has been used to provide a mechanism-design analysis of private banknote-issue systems (see Cavalcanti and Wallace, 1999 [CW, hereafter]).[1] A virtue of the model is its consistency with the main idea of modern monetary theory; namely, that money, whether it consists of private banknotes or the money issued by a central-bank monopoly, has a role because at least some people are imperfectly monitored in the sense that their previous actions are not common knowledge (see Ostroy, 1973; Townsend, 1989; Kocherlakota, 1998).

Here, following CW, there are two kinds of people. An exogenous fraction, the would-be issuers of private banknotes, are perfectly monitored in the sense that their actions are common knowledge. The rest are anonymous, not monitored at all, and their presence gives rise to a demand for money, which is best thought of as currency. Under the monopoly, there is a role for the monitored to borrow and lend among themselves. To allow that to occur, the model has two stages of trade at each date: a stage at which production and consumption occur in pairwise single-coincidence meetings and a centralized stage where the monitored borrow and lend and where central-bank intervention occurs—as in a federal funds or commercial paper market. To give a role for intervention in a simple way, there is a seasonal—a two-date periodic and deterministic aggregate productivity process.

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[1] One reason why central-bank monopolies may be desirable is that the existence of many monies, the private system, presents too many opportunities for counterfeiting. Counterfeiting is ruled out in CW.

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The marginal benefit of central-bank intervention is found by studying two maximization problems. In both, the objective is *ex ante*, prior to the permanent assignment of people into the monitored and anonymous groups, representative-agent welfare and the choice is over implementable two-date periodic allocations—essentially, trades and transfers—where implementability means subject to participation and truth-telling constraints. In the no-intervention problem, the planner is constrained to choose a constant stock of money. In the intervention problem, the planner can choose a two-date periodic stock of money, but must bring about changes in the quantity of money through transfers at the centralized stage—transfers that are also subject to the implementability constraints.

A role for central-bank intervention is tied to the role of money. A special case of the model has everyone monitored. In that case, the optimum is cashless and has no role for intervention. Even in the general case, optimal intervention does not take the form of paying interest on money. Instead, it resembles loans to the aggregate of would-be issuers of banknotes at one date with repayment at the next date. The optimum is displayed for one numerical example. And even though the model is very simple and even though money is a simple object in the model, optimal intervention does not seem simple.

## 2. The model

Time is discrete, there are two stages at each date, preferences are additively separable over dates, and there is a nonatomic unit measure of people who maximize expected discounted utility with discount factor $\beta \in (0,1)$. The first stage has pairwise meetings and the second stage has a centralized meeting. Just prior to the first stage, a person looks forward to being a consumer who meets a random producer with probability $1/K$, looks forward to being a producer who meets a random consumer with probability $1/K$, and looks forward to no pairwise meeting with probability $1-(2/K)$, where $K \geqslant 2$. The period utility of someone who becomes a consumer and consumes $q \in \mathbb{R}_+$ is $u(q)$, where $u$ is strictly increasing, strictly concave, differentiable, and satisfies $u(0)=0$ and $u'(0)=\infty$. The period utility of someone who becomes a producer and produces $q \in \mathbb{R}_+$ is $-q/\delta_t$, where $\delta_t$, the aggregate *productivity* at date $t$, is $\delta_l$ if $t$ is odd and $\delta_h$ if $t$ is even and $0<\delta_l<\delta_h$. Below, odd dates ($\delta_t=\delta_l$) are called low (productivity) dates and even dates ($\delta_t=\delta_h$) high (productivity) dates. Production is perishable; it is either consumed or lost.[2] There is no utility associated with actions at stage 2.

As in CW, an exogenous fraction of the population is perfectly monitored ($m$ people) and the remainder is not monitored at all ($n$ people). Money is indivisible and each person's holding is restricted to be in $\{0,1\}$ at the start of stage 1 and to be in $\{0,1,2\}$ at the start of stage 2. For $m$ people, histories and money holdings are common knowledge; for $n$ people, they are private. However, the monitored status and consumer-producer status (in a pairwise meeting) of each person are common knowledge. Finally, no one, except the planner, can commit to future actions.

In this economy, the best outcome subject only to physical feasibility is production and consumption at each date in each pairwise meeting equal to $\arg\max_q[u(q)-q/\delta_t]$, the output that maximizes *surplus*. For all sufficiently high discount factors, only the presence of the $n$ people prevents that outcome from being attained. In particular, an $n$ person must receive money in order to produce. Given the randomness of earning and consumption opportunities and even with large individual holdings of money, $n$ people who experience a string of consumption opportunities will tend to run out of money, while those who experience a string of earnings opportunities will not want to expend much effort to earn more. The assumption that money holdings are in $\{0,1\}$, which is adopted to limit the number of unknowns, gives rise to an exaggerated, but not misleading, version of the liquidity problem. Under that restriction, $n$ people with money are so rich that they cannot be induced to produce.

Given the randomness and the monopoly on money, $m$ people want to borrow and lend. That is the main role of stage 2. In this model, the borrowing and lending takes the form of insurance: $m$ people who produced tend to pay out; $m$ people who consumed tend to receive a transfer. Positive transfers to $n$ people at stage 2 are allowed—positive because $n$ people cannot be induced to surrender money at stage 2.

## 3. Stationary and implementable allocations

Allocations are symmetric in the sense that everyone in the same state at a date does the same thing. (Randomization is useful for proving that *ex ante* welfare is increasing in the fraction who are monitored, but, here, it adds too many unknowns.) In addition, allocations are stationary in that they are two-date periodic. The assumptions imply that the state of a person at the start of a date is in the set $\{m,n\}\times\{0,1\}$, while it is in $\{m,n\}\times\{0,1,2\}$ at the end of pairwise meetings. An allocation describes stage-1 trades, output and transfers of money, as a function of the states of the people in a meeting and the date (low and high); stage-2 transfers of money as a function of the state of a person and the date; and the fraction of each type ($m$ or $n$) who have money at the start of each date. Those fractions and the stage-1 trades and stage-2 transfers must satisfy the law of motion. At both stages, transfers of money are modeled as lotteries because money is indivisible.[3]

The only punishment is banishment of an individual $m$ person to the set of $n$-people. Underlying this assumption is free exit from the set of $m$-people and the ruling out of global punishments, like shutting down all trade, in response to

[2] Aside from the productivity process, this formulation is borrowed from Trejos and Wright (1995) and Shi (1995). If $K$ is an integer that exceeds two, then it can be interpreted as the number of goods and specialization types.

[3] Lotteries were introduced into search models of money in Berentsen et al. (2002).